NASA microgravity research highlights

Students Taking Part in Biological Crystal Growth Experiments

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The International Space Station (ISS) is proving to be not only a useful tool for research, but also a valuable educational tool. Last year, more than 100 high school students participated in preparing and loading samples of protein crystal solutions that were carried to the ISS September 8, 2000, on Space Shuttle Atlantis. The Student Access to Space program allowed students to contribute to protein crystal growth (PCG) experiments that may one day lead to improved drug design and treatment of disease. In addition, the program exposed the students to real-world science, enabling them to see how such advanced, seemingly esoteric research is made possible through the actions of everyday people, such as laboratory technicians, computer programmers, and research scientists.

The PCG experiments with which the students worked are headed by Principal Investigator Alexander McPherson, of the University of California, Irvine (UCI). For these experiments, hundreds of tiny tubes, each containing a frozen solution of protein, virus, or other macromolecule and precipitant in various concentrations, are loaded into the Enhanced Gaseous Nitrogen (EGN) Dewar, a simple, Thermos-like system used to freeze proteins and viruses until they reach orbit. After the solutions are taken to orbit, they are allowed to thaw, and the combination of the solution and precipitant causes crystals of the proteins to form. The microgravity environment experienced by vehicles in low Earth orbit is advantageous to PCG experiments because the near absence of convective flow in the samples as the crystals develop can enable the formation of larger crystals composed of molecules with atoms that are more neatly arranged. These crystals, in turn, allow scientists using X-ray diffraction to more easily determine the structure of the macromolecules.

The involvement of students in the preparation of actual NASA flight experiments came about when the UCI laboratory team realized that the process of preparing samples for crystallization is fairly simple, and would be an ideal way to allow students to take part in the microgravity research program. McPherson proposed the project, which was funded initially by NASA Headquarters' Education Division and subsequently by the Office of Space Flight. In addition, partnering groups such as the Alabama, Florida, and Texas Space Grant Consortiums; BellSouth Pioneers; and the Space Is Special Foundation help to sponsor the student work-shops during which the sample preparation takes place.

Sponsors purchase and distribute special PCG kits that allow teachers and students to grow protein crystals in their classrooms. Following the classroom activity, students enter into competition to be selected to attend a workshop. The type of competition varies by sponsor: some sponsors ask students who participated in the classroom activity to write about protein crystal growth in an essay; some have students devise projects. Sponsors then select approximately 20 to 30 students for each of the workshops, which have been held at Marshall Space Flight Center in Huntsville, Alabama; Grand Rapids, Michigan; Kennedy Space Center in Florida; and Mobile, Alabama. As part of the workshops, students are taken on tours of real-world structural biology laboratories and companies and are introduced to applications of PCG, which include disease prevention and treatment. They also, of course, spend a day preparing and loading the samples to be delivered to the ISS.

For each sample, the students work with a

These high school students are screening crystals of various proteins that are part of the ground-based work that supports Alexander McPherson's protein crystal growth experiment. The students also prepared and stored samples in the Enhanced Gaseous Nitrogen Dewar, which was launched on the STS-98 mission for delivery to the ISS. The crystals grown on the ground will be compared with crystals grown in orbit. Participants include (from left) Joseph Negron, of Terry Parker High School, Jacksonville, Florida; Megan Miskowski, of Ridgeview High School, Orange Park, Florida; and Sam Swank, of Fletcher High School, Neptune Beach, Florida.

length of tubing approximately 2.5-3 inches long and 0.125 inch in diameter. First, one end of the tube is crimped closed; following that, a solution with a specified concentration of precipitant is injected in the tube, and the tube is frozen in liquid nitrogen. Next, they inject the protein into the tube, freeze it, inspect it, and crimp the other end closed. The protein-precipitant combinations are made up according to a matrix of solutions that will be tested in microgravity. Because crystallization is so affected by fluid flow, and fluid flow is so affected by the absence of gravity, it is quite difficult to predict which combinations will result in the most effective crystals. Therefore, many, many samples are prepared covering a large number of possible combinations.

The EGN Dewar that was taken to the ISS on STS-106 last September contained nearly 500 samples of proteins, including lysozyme (a protein used as a model to better understand how microgravity crystal growth differs from Earth-based crystallization), thau-matin (a sweet-tasting protein with potential as a commercial sweetener), and canavalin (a plant-based major source of dietary protein for humans and domestic animals). Of those 500 samples, nearly a quarter were student-prepared. The crystals were retrieved by STS-92 in late October, and analysis of the crystals that grew on the station is still being performed.

Meanwhile, more student workshops have taken place in preparation for the inclusion of the EGN Dewar on STS-98, which was launched February 7. The student workshop participants (and some teachers) came from Alabama, California, Florida, Michigan, Tennessee, and Texas. Approximately 250 samples were loaded and prepared in these workshops, and as many as could fit in the space allotted (at least 150, making sure that each student and teacher will have at least one sample onboard) were flown for over a month on the ISS and retrieved by STS-102 in March. Greg Jenkins, student project manager for the EGN Dewar experiments, says that the project arranged to take students and teachers to Kennedy Space Center to view the launch of the shuttle containing their hard work. “We really try to make it a very special experience for them,” he says, “because they’ve overcome peer pressure in doing science, and we’d really like for it to get back that these students are receiving something good from science.”

Additional information

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